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A COMMENTARY ON PERFORMANCE-BASED FIRE SAFETY DESIGN AND FIRE MODELING

By Richard Schulte

Dr. Alan Beard's article titled "*Reliability of Computer Models in Fire Safety Design*" which appeared in the April 2008 issue of *Industrial Fire Journal* should have caused quite a stir in the fire safety field, but it appears that many, if not most, in the field simply dismissed the article. Given what Dr. Beard wrote, it is difficult to understand why there was (and is) so little interest in Dr. Beard's commentary on fire modeling.

A paper titled "*Performance-Based Building Codes: What Will Happen to the Levels of Safety?*" authored by Dr. Vytenis Babrauskas, circa 1999, also contains some of the same concerns as expressed by Dr. Beard. Perhaps the main difference between Dr. Beard's article and Dr. Babrauskas' paper is the manner in which their concerns are expressed. While Dr. Beard's commentary is direct, Dr. Babrauskas's comments are less so.

Excerpts from Dr. Babrauskas' paper from 1999 include the following:

> "*. . .fire safety engineering is a profession hardly 30 years old.*"

> "*. . .Simply put, performance-based design, when applied to fire safety, means the use of fire safety engineering for design purposes. Here, I will draw a carefully narrow definition of "engineering": problem solving by a quantitative application of scientific laws. By this definition, fire safety engineering is a profession hardly 30 years old. This is because fire safety science, which is the pertinent science, has only been in existence for about that time period.*"

> "*Structural design, by contrast, has been done on the basis of engineering, rather than empirical technology, for close to 200 years now. In much of the discussion in building codes, there is an automatic leap made that, if structural design can be reliably done on an engineering basis, all that is needed in the fire safety area is to emulate the strategies used there, and fire safety aspects of building codes can readily be converted to a performance (i.e., engineering) basis.*"

"*But there are significant pitfalls to a hasty adoption of performance-based fire safety design, and in this paper I will examine some of the most salient one.*"

"*The general concern is that, if implemented the way now proposed, the IBC Performance Track will lead to designs where much less fire safety is being provided than under current, prescriptive regulations.*"

"*It is by no means an easy feat to quantify the level of safety.*"

"*The IBC performance track does not even consider how to quantify the level of safety, with "sufficiency" being viewed as an adequate principle.*"

"*Judging by present indicators, FSE-based designs are precisely likely to lower fire safety levels without the public's awareness or input.*"

"*What is curious is that, of all the countries which have drafted performance-based building codes so far, only one country—Japan—has seen fit to even state as an explicit objective that as many fire-safety subsystems as possible will be provided with a quantitative performance assessment formula.*"

"*One feature which is very striking in most of the FSE-based design schemes is the assumption that fire dynamics is perfectly well known. As outlined above, fire safety engineering is a young profession. Most observers would consider that it is at a stage where, say, civil or mechanical engineering was about 50 years ago."*

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"*As outlined above, fire safety engineering is a young profession. Most observers would consider that it is at a stage where, say, civil or mechanical engineering was about 50 years ago. . .*"

"*The world's experimental data base in fire physics and chemistry is immature and limited, especially so as concerns large buildings or spaces. Very few experiments have been reported in spaces more than 3~4 m in scale, yet FSE-based designs are precisely being advocated for some of the world's largest engineering projects."*

"*The world's experimental data base in fire physics and chemistry is immature and limited, especially so as concerns large buildings or spaces.*"

"*The development of engineer tools, i.e., computer codes which are used to apply the fire dynamics knowledge to design problems, is stagnant and is receiving minuscule governmental-agency support.*"

"*The lack of recent progress in experimental fire dynamics can perhaps most easily be seen by comparing the second edition of the SFPE Handbook to the first one. The first edition, published in 1988, was a phenomenal leap forward over what was available before. But the second edition in 1995, while incorporating more material in certain areas remote from fire physics/ chemistry, shows only small advances over the first in the crucial fire dynamics area. This is because the needed new research to include simply was not there. Based on available fire dynamics data, designers often have to make extrapolations of 1 or 2 orders of magnitude. Yet at the moment, there seems to be little hope that needed research will be undertaken to fix this situation.*"

"*The development of engineer tools, i.e., computer codes which are used to apply the fire dynamics knowledge to design problems, is stagnant . . .*"

"*Examining the shortcomings of the fire models of 1994, I concluded that there were a number of very basic deficiencies [6][7]:. . .What is of concern is that in the intervening five years, not only has a new generation of engineer tools not been seen, but the areas of fire dynamics needing research failed to attract it.*"

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"*A cornerstone of all FSE-based approaches is starting with a design fire. This is reasonable, but how should that design fire be determined, though?*"

"*The use of the t^2 fires first arose in the early 1970s, when quantitative performance evaluation of fire detectors was first being attempted.*"

"*Such small fires, however, are not the appropriate focus for modeling the general fire hazard in buildings*"

"*Efforts must be made to quantify the level of safety.*"

"*The final consideration is that to develop a workable, safe performance-based building code is* ***a very difficult endeavor****. Many of the prerequisites needed are simply not in place today. Thus, working towards the day when FSE-based fire safety designs will flourish is a noble effort, but precipitous haste is not. The consequences of such haste are likely to be erection of buildings with serious fire safety shortcomings.*"

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Discussion

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While Dr. Babrauskas' commentary on performance-based fire safety design and fire modeling from 11 years ago might be considered to be "ancient history" by some in the field of fire safety, much of the commentary is still relevant in 2010. When you compare Dr. Babrauskas' commentary to Dr. Beard's opinions on fire modeling expressed in the article which appeared in *Industrial Fire Journal*, there is little doubt that the commentary on the use of fire modeling for engineering design is indeed similar.

As a profession, engineers in the fire safety field have charged ahead into "the brave new world" of fire modeling without, perhaps, understanding the limitations on the computer models. Obviously, having this called to their attention is a little more than embarrassing for the field.

How do the "fire modeling elites" hide their embarrassment? Simply ignore the precautionary comments made by Dr. Babrauskas and Dr. Beard, and to quote a naval hero from the Civil War, Admiral David Farragut, "*damn the torpedoes, full speed ahead*".

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>
> Admiral David Farragut, USN

Given the extent that the fire safety profession has so readily adopted the use of fire models, the profession has created a major liability problem for itself. If major flaws are found in the fire models that engineering firms have been utilizing in the design of buildings, it would seem that building owners have a cause to pursue litigation against those firms. Hence, it seems rational that many in fire safety field would rather ignore any commentary which urges caution in the use of fire models and simply pretend that there are no problems with the use of the models.

Imagine having to re-design a large building after the building has already been constructed due to the fact that flawed or improperly implemented models were utilized in the design? Given the fact that the profession has rushed to utilize models in building design, it seems that the fire safety profession should be bracing for the potential of litigation, perhaps in the very near future.

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